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Complexity in Project Management

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Abstract

Understanding complexity is of significance importance for project managers because of the differences associated with decision making and goal attainment that appear to be related to complex projects. As projects have become more and more complex there has been an increasing concern about the concept of project complexity as it influences upon the project management process. The importance of complexity to the project management process is widely acknowledged for several reasons. Complexity affects the modelling, evaluation, and control of projects and the objectives of time, cost, quality and safety. Complexity can also affect the selection of an appropriate project organization form and the project management arrangement including the expertise and experience requirements of project managers. In this paper the concept of project complexity is analysed and the main models of project complexity are presented. Our results evidence two aspects, the lack of consensus when defining project complexity and the fact that the focus of complexity models is basically on goals and methods, the level of agreement and certainty or the number of elements and their interdependency no taking into account other critical aspects of complexity.

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Keywords: Project Management; Complexity; Complexity models

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1. Introduction

An understanding of project complexity and how it might be managed is of significance importance for project managers because of the differences associated with decision making and goal attainment that appear to be related to complexity[1,2]. As projects have become more and more complex there has been an increasing concern about the concept of project complexity and the application of traditional tools and techniques developed for simple projects have been found to be inappropriate for complex projects[1,3].

The importance of complexity to the project management process is widely acknowledged for several reasons[4,11]: (i) it helps determine planning, coordination and control requirements; (ii) it hinders the clear identification of goals and objectives of major projects; (iii) it can affect the selection of an appropriate project organization form and experience requirements of management personnel; (iv) it can be used as a criteria in the selection of a suitable project management arrangement; (v) it can affect different project outcomes (time, cost, quality, safety, etc.). In this paper the concept of project complexity is analysed and the main models of project complexity are presented. The paper is organized as follows. The next section shows the concept of project complexity. Section 3 presents the main models of project complexity in the literature and Section 4 provides the main conclusions and guidance for future research.

2. The concept of complexity

There is a lack of consensus on what complexity really is in project contexts[12-15]. Even, there does not seem to be a single definition of project complexity that can capture the whole concept. In fact, definitions of complexity continues to be ambiguous[16-19]. Complexity can be understood not only in different fields but has also different connotations within the same field[20]. Edmons[21] proposes a generic definition of what complexity is related to the way the project system is modelled

There exist many definitions of complexity. A very basic and simple definition of complexity starts by describing the number of different elements in a system alone as its complicacy and the number of elements in a system and the possible relations among these elements as complexity[2].

Within the Luhmannian system theory, complexity is the sum of the following components[22]: The differentiation of functions in a project between clients, contractors, subcontractors, suppliers, banks, etc., or the internal differentiation of the contractor's organization (degree of manifoldness); The dependencies between supersystems, systems, and the different subsystems or amo0ng the latter ones (interrelatedness); and the consequential impact or processes of a decision field. Baccarini[1] views complexity as consisting of many varied interrelated parts while Ward and Chapman[23] view the number of influencing factors and their interdependencies as constituents of complexity. Tatikonda and Rosenthal[24] view complexity as consisting of interdependencies among the product and process technologies, novelty and difficulty of goals. Vidal et al[14] claim that complexity can be viewed as a property of the system that makes it difficult to understand and Pitch et al[25] define complexity as information inadequacy when too many variables interact.

Some authors consider uncertainty as a component of complexity and vice versa. Williams[26] views the number of elements and their interrelationships as constituents of structural uncertainty which is proposed as an element of complexity. Shenhar[27] regards complexity and uncertainty as orthogonal to each other. Somner and Loch[28] treat complexity and unforeseeable uncertainty as separate constructs. Atkinson et al., (2006) consider complexity as an element of uncertainty while Geraldi and Adlbrecht[29] and Geraldi et al[13] support uncertainty as an element of complexity. Perminova et al[30] equate complexity to systematic uncertainty.

3. Complexity models

Gidado[4] determines four different sources of complexity: employed resources, environment, level of scientific and technological knowledge required, and number of different parts in the work flow (a large amount of required resources, a turbulent environment, working on the edge of technology and innumerable possible interactions are certainly identifiable for complex projects). This definition seems to be just related to task complexity and does not consider others possible layers of complexity such as social complexity (i.e., the numbers and diversity of actors communicating and working with each other); cultural complexity (it compresses the history, experience, and sense-

making processes of different groups that joint the effort in a project); operative complexity (i.e., the degree to which organizations of the project are independent when defining their operations to achieve given goals), and cognitive complexity which can be treated on the level of a person or the level of a group (i.e., the degree to which self-reflection, the emergence of an identity, or even an organizational culture, is possible. Next we will analyse some of the most relevant complexity models in the project management context.

3.1. Goals and Methods Matrix.

Turner and Cochrane[31] classify projects according to how well defined goals and how well defined are the methods of achieving these goals in a project. According to these parameters Turner and Cochrane (1993) develop a Goals and Methods Matrix where four types of projects can be found: (*i)* Type 1 projects are projects well defined and understood. In this case, the role of the project manager is that of a conductor; (*ii*) Type 2 projects are projects with well defined goals but poorly defined activities. In this case the role of the project manager is that of a coach and project planning has to be done on a rolling wave technique as information becomes available; (*iii*) Type 3 projects are projects with poorly defined goals but well defined methods. These projects are planned in life-cycle stages and in this case the role of the project manager is that of a craftsman[32]; and (*iv*) Type 4 projects are projects with no defined goals and no defined methods.

3.2. Stacey's Agreement and Certainty Matrix

Stacey[33] analyses complexity on two dimensions, the degree of certainty and the level of agreement, and develops a matrix with the following zones: (*i)* close to agreement, close to certainty. In this zone we can find simple projects where traditional project management techniques work well and the goal is to identify the right process where efficiency and effectiveness is maximized; (*ii*) Far from agreement, close to certainty. In this case, coalitions, compromise, and negotiations are used to solve this type of situation where techniques such as Game Theory or Hypergames can be used to solve it; (*iii*) Close to agreement, far from certainty. In this case traditional project management techniques may not work and leadership approaches can be used to this type of situations; (*iv*) Far from agreement far form certainty. This is zone of anarchy where with a high level of uncertainty and where traditional management techniques will not work. Leadership approaches may be useful in this type of situation.

3.3. Complexity model suggested by Williams.

Williams[34] extends Baccarini's model by one additional dimension. In addition to the two components of complexity suggested by Baccarini, i.e., number of elements and the interdependency of these elements, Williams introduces uncertainty and attributes the increasing complexity in projects to two compounding causes, the relationship between product complexity and project complexity and the length of projects which have become more time constrained (Ameen…).

4. Concluding section and future research

When problems fundamentally dynamic are treated statically, delays and cost overruns are common. Experience suggests that the interrelationships between the project's components are more complex that is suggested by the traditional techniques. Thus, traditional approaches utilizing a static approach may provide project managers with unrealistic estimations that may ignore multiple feedback processes and nonlinear relationships of a project or be inadequate to the challenge of today's dynamic project environment.

Systems thinking is the cognitive process of studying systems of every kind. A system may be defined in general as a set of interrelated or interacting elements. In biology, a living organism is seen as a set of organs, muscles, etc., that interact in the processes to sustain the organism. In business, the organization is seen as a set of people and

machines that interact in processes to achieve business. Systems thinking is an approach to problem solving by seeing wholes, by seeing interrelationships rather than things, by seeing patterns of change rather than static snapshots, by seeing problems as parts of an overall system rather than reacting to specific parts. In contrast to Descarte´s scientific reductionism and philosophical analysis, systems thinking creates a holistic view of the problem that helps to identify the dynamics of the system that results from interactions between its components. Systems thinking attempts to illustrate how small catalytic events that are separated by distance and time can be the cause of significant changes in complex systems.

Systems thinking has roots in a diverse range of sources and stems from several routes. We can find roots from J. Smuts' holism in the 1920s to the General Systems Theory that was advanced by Bertalanffy in the 1940s and cybernetics advanced by R. Ashby in the 1950s. The field was further developed by J. Forrester who applied general systems theory to organizational systems in business and culminated in the popular book The Fifth Discipline by P. Senge which defined systems thinking as the capstone for time organizational learning. Systems thinking stems from the study of complex organisational systems, as in biology, economics, sociology or from organization theory where new and important characteristics emerge the higher the level of analysis, the so-called emergence and hierarchy. Systems thinking is contributing to theories on learning in projects, i.e., theories on how project work causes learning at the organizational as well as the individual level, and how this learning can be made useful to the organization in subsequent projects.

An alternative view of the project is offered by system thinking which concentrates on the whole project. System thinking assumes a holistic view of the organization focusing on the behavioral trends of projects and their relation with managerial strategies. Systems thinking can help us to define and identify the underlying notions behind the concept of project complexity, to identify and evaluate the factors that make a project complex, or to interpret and measure project complexity. It can also help us to identify the characteristics that should be incorporated in a project management process in order to deal with this complex, dynamic, and uncertain environment both at the strategic, tactical and operational level.

In this paper the concept of project complexity is analyzed and the main models of project complexity are presented. Our results evidence, on the one side, the lack of consensus when defining project complexity and, on the other side, the fact that the analyzed complexity models do not take into account critical aspects of complexity. Requirements of a good project complexity model must take into account not only the number of elements and their interdependencies, but also the social and political context, and project manager's skills such as shared leadership, emotional intelligence, vision, values and beliefs, etc.

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